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emanation from 0.37 g. of radium. The quantity of emanation which was effectively destroyed in the apparatus was a little less and was equivalent to the saturated emanation from 0.27 g. of radium. When the experiment was considered finished, the solution was transferred from the apparatus into a platinum crucible and a few drops of nitric acid added. Into this same crucible we dipped a piece of platinum foil on which we deposited the copper. When the solution was freed from copper, it was evaporated to dryness in the crucible and the latter was heated just enough to drive off the sulphuric acid. The residue was dissolved in a few drops of water and treated with hydrogen sulphide to remove the last traces of copper still remaining. The liquid was filtered through a platinum filter into a platinum watch-glass of known weight and was evaporated to dryness at a very moderate temperature. The minute residue was weighed.

The same treatment was applied to 7 c.c. of a copper sulphate solution which had not been subjected to the action of radium. The final residues were examined spectroscopically. Their weights were 0.0004 g. and 0.0005 g. in the real experiments, 0.0003 g. and 0.0002 g. in the blanks. It is to be noted that the amount of copper taken is very close to that used by Mr. Ramsay. The amount of emanation consumed is also approximately the same (1.85 mm.³ in Mr. Ramsay's phraseology). In spite of this, the residue finally obtained is much less.

The spectroscopic examination showed that the residue consisted chiefly of sodium with a little potassium; the presence of lithium could not be established. An experiment with a mixture of sodium and lithium sulphates showed that we could detect, though only with difficulty, the presence of one part of lithium sulphate in ten thousand parts of sodium sulphate. With the same ray it was easy to detect one part of lithium sulphate in three thousand parts of sodium sulphate. Consequently the amount of the metal lithium which could be present was less than 0.6×10^{-5} milligrams.

With the same amounts of copper and of

emanation, Messrs. Ramsay and Cameron found 1.7×10^{-4} milligrams of lithium. If there is an error in calculation and this number refers to lithium chloride, there would still be 3×10^{-5} milligrams of metallic lithium.

The residue which we obtained was in each case much less than that obtained by Messrs. Ramsay and Cameron and this difference is probably due to our not using glass vessels. The difference in the weights of the residues obtained by us in the real experiments and the blanks is very small (0.1 to 0.3 milligram). The difference is probably due to the introduction of traces of foreign substances into the apparatus along with the emanation. In the most reliable experiment of Messrs. Ramsay and Cameron, the same difference is 0.88 milligram and we believe that this is due to the solution attacking the glass more vigorously in presence of the emanation.

The following check experiment was made. Into a copper sulphate solution containing 0.27 g. of copper we introduced an amount of lithium sulphate corresponding to 1.7×10^{-4} milligrams of LiCl; this solution was then treated in the same way as in the other blank experiments. In the residue finally obtained it was very easy to see the red ray of lithium. This shows that the lithium was not eliminated by the treatment adopted.

To sum up, we must say that we have not succeeded in confirming the experiments of Messrs. Ramsay and Cameron. It is evidently impossible for us to say that no trace of sodium or lithium is formed during the experiment. We believe, however, that the formation of these elements can not be considered as an established fact.

SPECIAL ARTICLES

MOMENTUM EFFECTS IN ELECTRIC DISCHARGE

IN the issue of July 17 a partial report was made of experiments on electric discharge around a right angle in a wire. Since then some of the methods have been modified, and additional results have been reached.

In all of the work thus far, an eight-plate static machine has been used. It may be

driven by hand or by a motor. Sparks from four to eight inches long are taken from the two terminals into parallel conductors having high resistance. These resistances consist of long, thin strips of cloth moistened with salt solution. These lines spark to ground contacts, which are about fifty feet apart, in the yard outside.

A thin wire is bent into a series of sharp right angles. This wire may be looped into either the positive or the negative line. Photographic plates inclosed in hard rubber holders are placed at these angles. Some of them are exposed to the wire on the ground side of the angle, and some on the machine side. Their distance must be so adjusted that they give symmetrical results when the spark discharge around the angles is reversed.

With the negative discharge the plates on the ground side of the angles are much more strongly fogged than those on the machine side. Negative electrons having a mass of about one one-thousandth of that of the hydrogen atom leave the wire at the angle, because they can not turn the corner. They pass on through the cover of the hard-rubber holder, which may be three sixteenths of an inch thick, and fog the plate, which is developed in the ordinary way. These particles have momentum. They have energy of motion. They are a component of matter, as is well established by radio-active phenomena, and by well-known electrical experiments.

When the wire having these angles is looped into the line from the positive side of the machine this effect is also observed, but it is very much feebler. With a cover to the holders one sixteenth of an inch thick, 9,000 spark discharges in the positive line produce about the same intensity of image as is obtained with a single spark in the negative line. And here the effect is vastly stronger on the machine side of the angle than on the ground side. The negative electrons are therefore doing the work in the positive line also. They flow through this line from the ground to the machine. But they are not forced in under pressure, as they are forced out from the machine on the negative line. It is these little particles of negative electricity which consti-

tute the electric current. They have kinetic energy which they impart to the conductors through which they are beating their way. In an arc light they plunge across from the negative carbon to the positive carbon. Their impact upon the positive carbon results in the formation of a crater which is intensely heated. About 85 per cent. of the light comes from this crater in the end of the positive carbon, which is, as has long been known, more than 1,000 degrees centigrade, or 1,800 degrees Fahrenheit, hotter than the negative carbon.

In order to obtain the results here described electrical oscillations must be prevented. This is attained by means of the moistened strips of cloth. When this has been accomplished the sparks are large and brilliant at the negative end in both positive and negative lines, and thin out towards the positive end. The negative terminals are large spheres of about 10 cm. diameter. The positive terminals are small knobs, of about 1 cm. diameter. While on the large spheres the electrons repel each other. But when they start into motion across the spark-gap, they attract each other electromagnetically. This appears to be the reason why the spark thins out as the electrons proceed in their motion across the spark-gap. A "fat" spark is a sure indication of an oscillating discharge.

The fact that sharp shadow pictures are formed of any thin object like a glass slide lying on the photographic film under the wire, shows very clearly that these effects are due to a cathode discharge. Whether or not X-ray effects are also involved, is still an open question.

Arrangements are now being made to place the angle-wire in a vacuum tube. This may perhaps render these momentum effects visible.

FRANCIS E. NIPHER

SPINAL SHOCK: A PRELIMINARY NOTE

A FEW months ago, the writer, in conjunction with Professors G. N. Stewart and C. C. Guthrie, stated his belief that the cause of spinal shock lies solely in the interruption of the long conduction pathways of the spinal